OUTLINE OF FINDINGS AND DATA GAPS

Preparation of a Comprehensive Habitat Restoration Plan for the Onondaga Lake Watershed

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Prepared For:

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ACJ	Amended Consent Judgement
A-E	Architect-Engineer
AMP	Ambient Monitoring Program
ASLF	Atlantic States Legal Foundation
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CHRP	Comprehensive Habitat Restoration Plan
CSO	Combined sewer overflow
EPA	Environmental Protection Agency
GIS	Geographic Information Systems
MRLC	Multi-Resolution Land Characteristics
NHD	National Hydrography Dataset
NRCS	National Resources Conservation Service
NWI	National Wetlands Inventory
NYSDEC	New York State Department of Environmental Conservation
OCDWEP	Onondaga County Department of Water Environment Protection
OCPL	Onondaga County Public Library
OLCC	Onondaga Lake Cleanup Corporation
OLMP	Onondaga Lake Management Plan
OLP	Onondaga Lake Partnership
PCB	Polychlorinated Biphenyl
QEA	Quantitative Environmental Analysis
RI/FS	Remedial investigation/feasibility study
STATSGO	State Soil Geographic
SU	Syracuse University
SUNY ESF	State University of New York College of Environmental Science and Forestry
USACE	United States Army Corps of Engineers
USF&W	United States Fish and Wildlife
USGS	United States Geological Survey

SECTION 1

INTRODUCTION

1.1 PROJECT OVERVIEW

Parsons has been retained by the United States Army Corps of Engineers (USACE) – Buffalo District to prepare a Comprehensive Habitat Restoration Plan (CHRP) for the Onondaga Lake watershed. The intent of this plan is to evaluate the inherent capability of this watershed to support fish and wildlife and to develop alternative conceptual strategies for improving aquatic, wetland, and upland habitats using sound ecological principles. The first project task was to collect, compile, review, and analyze existing information (1970 to present) and to identify any data gaps that would facilitate the development of the CHRP.

The intent of this report is to summarize the data collection and literature review efforts. Literature pertaining to habitat restoration has been compiled into two tables: Table 1 identifies the reviewed literature sources and Table 2 identifies the analytical data (in-stream water quality, aquatic biota) and GIS database information (hydrography, substrate/soils, land use, wetlands/riparian areas and topography) including data sources, spatial and temporal coverage, format, and status of the data (i.e., received or not yet obtained). Reference numbers cited in the text of this report correspond to the reference numbers in Table 1. A summary of the literature and database sources reviewed is listed below:

- Atlantic States Legal Foundation, Inc (ASLF);
- Bibliography of Onondaga Lake A Plan for Action (Onondaga Lake Management Plan (OLMP));
- Environmental Protection Agency (EPA) website, http://www.epa.gov/ ;
- Multi-Resolution Land Characteristics (MRLC);
- National Hydrography Dataset (NHD);
- New York State Department of Environmental Conservation (NYSDEC);
- National Wetlands Inventory (NWI);
- Onondaga County Department of Water Environment Protection (OCDWEP) Bibliography of Technical Material Pertaining to Onondaga Lake, New York, revised September 2002;
- Onondaga County Public Library (OCPL), online catalog, http://www.ocpl.lib.ny.us/;
- Onondaga Lake Cleanup Corporation (OLCC) list of Reports for Projects Authorized for Funding by the Onondaga Lake Management Conference;
- Quantitative Environmental Analysis, LLC (QEA) Reference List;
- New York Guidelines for Urban Erosion & Sediment Control;

- State Soil Geographic (STATSGO) soils data compiled by the National Resources Conservation Service (NRCS);
- Syracuse University (SU) and State University of New York College of Environmental Science and Forestry (SUNY ESF) Library, the SUMMIT catalog, http://summit.syr.edu;
- United States Department of Agriculture, Natural Resources Conservation Service;
- United States Fish and Wildlife (USF&W);
- United States Geological Survey (USGS); and
- Other published documents prepared by environmental consulting firms (i.e., O'Brien & Gere Engineers, PTI (now Exponent), TAMS etc.).

The sources listed above are believed to contain most of the published information and research conducted on Onondaga Lake as applicable to habitat restoration in the watershed as of the date this report was prepared. There may be additional literature on the subject of Onondaga Lake, which is not referenced herein. Also, the accuracy and completeness of the literature provided cannot be verified beyond documenting the literature source.

The objectives of the second task for development of a CHRP will be to identify general goals and objectives for habitat restoration based on the findings of this literature review. Potentially relevant information will likely include quantitative population surveys and qualitative inventories from the literature and database sources listed above. Aerial photographs, soil maps, National Wetland Inventory maps, USGS quadrangle topographic maps, and municipal and private maps will be used to identify floodplains, wetlands, and green space along the lake and tributary corridors.

1.2 WATERSHED HABITAT RESTORATION

A watershed is an area from which water drains to a particular body of water. It's the area of land that catches precipitation and drains or seeps water into a wetland, stream, river, lake or groundwater. Watersheds can range in size from a few acres to hundreds of acres. Physical boundaries, such as hills or ridgelines generally act as the boundary between adjacent watersheds.

The ability of a watershed to support fish and wildlife is dependent upon the presence of well-vegetated terrestrial buffer communities surrounding the watershed's wetlands, tributaries, and lakes. The diverse habitats created by these vegetative communities allow for high fish and wildlife biological diversity, productivity, and movement throughout the watershed. The size of the vegetated buffer will be dependent on site-specific chemical, physical, and biological properties.

Urbanized watersheds, such as the Onondaga Lake watershed, often lack adequate vegetated buffers and intact wetlands, thus creating fragmented corridors that limit the movement and dispersal of fish and wildlife throughout a watershed. Fragmented buffers promote the degradation of in-stream fish habitats and reduce water quality in the watershed. In addition, loss of stream gradient, channelization of meandering sections, and replacement of riffle and

pool complexes with straight, shallow, often silty stream channels can severely impact fishery resources reducing fish species diversity.

1.3 ONONDAGA LAKE WATERSHED

The Onondaga Lake watershed encompasses approximately 248 square miles (642 square kilometers), is located almost entirely within Onondaga County, and includes rural, agricultural, and urban areas. The watershed includes six natural tributaries: Nine Mile Creek, Harbor Brook, Onondaga Creek, Ley Creek, Bloody Brook, and Sawmill Creek; and two constructed (i.e., man-made) tributaries: Tributary 5A and the East Flume. Onondaga Lake also receives influent from the Metropolitan Syracuse Treatment Plant located along the southeastern shore of the lake. The outlet of Onondaga Lake flows north to the Seneca River, which combines flow with the Oneida River to form the Oswego River, which ultimately discharges into Lake Ontario (Reference 8). The Onondaga Lake watershed and each major subwatershed are shown in Figure 1.

The land surrounding Onondaga Lake historically consisted of virgin forests and extensive marshlands (References 5 and 17). Today, the land bordering the lake consists principally of county parks (including Long Branch and Onondaga Lake Park), a marina, industrial properties, wetlands, undeveloped brush land, and highways (Reference 23). Much of the shoreline is owned by Onondaga County and is maintained as part of a park and trail system. The lakeside park is used for secondary water contact recreation, including boating and catch and release fishing (Reference 8).

Onondaga Lake has been impacted by both domestic and industrial pollution relating to population growth and industrialization in surrounding areas. Major pollutants of concern include phosphorus, ammonia, bacteria, mercury, and polychlorinated biphenyls (PCBs). In addition to these pollutants, other environmental stressors (i.e., sedimentation, salinity and non-point source runoff) have significantly altered the quality of fish and wildlife habitats within the lake and adjoining tributaries.

Onondaga Lake's water quality and the condition of its waterfront have improved significantly since the passage of the Clean Water Act in 1972 in response to wastewater treatment plant upgrades, combined sewer overflow (CSO) abatement measures, and the closure of the chlor-alkali plant and associated facilities. Data reports from the Onondaga Lake Ambient Monitoring Program (AMP) document a link between improved water quality and the number and types of plants and animals the lake can support (Reference 8). Continued monitoring will document the rate and extent of the lake's rehabilitation and assist in the development of a plan to accelerate the process. Efforts to restore Onondaga Lake will continue through the present century (Reference 19).

The Amended Consent Judgment (ACJ), which was passed in 1998, details a comprehensive program of sewage and combined sewer overflow (CSO) management upgrades. The Onondaga Lake Partnership (OLP), which was formed in 1999 and lead by the USACE provides a framework for local, state, and federal governments to cooperate in restoring the Onondaga Lake watershed (Reference 19). The industrial waste sites within the greater Onondaga Lake drainage basin are now in various stages of investigation or remediation (Reference 19). In most cases,

the selected remedial alternative for each site will likely include elements of habitat restoration. Current schedules for remediating individual sites extend as far as 2008 (Reference 21).

1.4 LITERATURE REVIEW REPORT OUTLINE

Project description, general watershed definition and overview of the Onondaga Lake watershed are presented in Section 1. Literature sources identifying habitat variables and terrestrial and aquatic habitat restoration techniques are described in Section 2. Data gaps that may inhibit the development of a Comprehensive Habitat Restoration Plan are listed in Section 3. Habitat restoration as it applies to the Onondaga Lake watershed is summarized in Section 4.

TABLE 1:
SUMMARY OF LITERATURE REVIEWED
ONONDAGA LAKE HABITAT RESTORATION

No.	Title	Date	Type	Author	Agency/Source	Issue (I) Volume (V)	Status
1	Proposal to Issue and Modify Nationwide Permits	Jul-99	Federal Register	Department of the Army Corps of Engineers	United States Army Corps of Engineers	(V): 64, No. 139	Received
2	Final Notice of Issuance and Modification of Nationwide Permits	Mar-00	Federal Register	Department of the Army Corps of Engineers	United States Army Corps of Engineers	(V): 65, No. 47	Received
3	The Highway Methodology Workbook (Supplement): Wetland Function and Values, A Descriptive Approach	1995	Publication	United States Army Corps of Engineers (New England Division)	United States Army Corps of Engineers	NEDEP-3600-1-30a	Received
4	The Onondaga Lake Watershed	2003	Website	Onondaga Lake Partnership	http://www.onlakepartners.org	NA	Received
5	Wildlife and Habitats of the Onondaga Lake Area - A Review	Aug-92	Report	VanDruff, L.W. and M.A. Pike	SUNY-ESF	NA	Received
6	An Annotated Key to the Woody Plants of Onondaga County, New York	1973	Book	Harding, A.	SUNY-ESF	NA	Received
7	Checklist of the Vascular Plants of Onondaga County, New York	Jan-61	Book	Faust, M. E.	Bulletin of the Syracuse Museum of Natural Science	No. 9	Received
8	Onondaga Lake Ambient Monitoring Program Executive Summary 2001 Annual Report	Aug-02	Report	Onondaga County Department of Water Environment Protection	http://www.ongov.net/WEP/wepdf/we15a.pdf	NA	Received
9	Topographical maps, (7.5 Minute Series. 1:24,000 Scale for Quadrangles)	1955-1978	Maps	United States Department of the Interior Geological Survey: Baldwinsville (1978); Camillus (1955); Cicero (1978); Marcellus 91976); Otisco Valley (1955); South Onondaga (1973); Syracuse East (1978); Syracuse West (1978), and Tully (1955)	United States Geological Survey	NA	Received
10	Baseline Conditions Memorandum, Trail Section 3C of the Onondaga lake Trail and Habitat Project	Feb-03	Report	Parsons	U.S. Army Buffalo District Corps of Engineers	NA	Received
11	Re-Evaluation Statement, Onondaga lake Canalways Trail, City of Syracuse and Towns of Salina and Geddes, Onondaga County, New York	Mar-02	Report	Onondaga County Department of Transportation	Onondaga County Department of Transportation	NA	Received
12	Final Design Report, Onondaga Lake Bikeway East-West Shore Link, City of Syracuse and Towns of Salina and Geddes, Onondaga County, New York	Dec-92	Report	Onondaga County Department of Transportation	Onondaga County Department of Transportation	NA	Received
13	Geddes Brook/Nine Mile Creek, Baseline Ecological Risk Assessment	Jul-03	Assessment	TAMS Consultants, Inc. and YEC, Inc.	NYSDEC	(v) 2 of 2 (Appendices)	Received
14	Onondaga Lake Baseline Ecological Risk Assessment	Dec-02	Assessment	TAMS Consultants, Inc. and YEC, Inc.	NYSDEC	(v) 2 of 2 (Appendices)	Received
15	Geddes Brook/Nine Mile Creek, Baseline Ecological Risk Assessment	Jul-03	Assessment	TAMS Consultants, Inc. and YEC, Inc.	NYSDEC	(v) 1 of 2 (Text, Tables, Figures)	Received
16	Wetlands of Onondaga County, New York	1974	Book	Alexander, M. M., J. Kruzan, R. Myers and A. Petty	Onondaga County Environmental Management Council	NA	Received

Notes:
NA-Reference was reviewed but was not cited in the text

TABLE 1:
SUMMARY OF LITERATURE REVIEWED
ONONDAGA LAKE HABITAT RESTORATION

No.	Title	Date	Type	Author	Agency/Source	Issue (I) Volume (V)	Status
17	The Golden Age of Onondaga Lake Resorts	Jun-05	Book	Thompson, D.	Purple Mountain Press, Ltd. P.O. Box 309, Fleischmans, NY 12430	NA	Received
18	Onondaga Lake	Jun-05	Website	Upstate Freshwater Institute	http://www.upstatefreshwater.org	NA	Received
19	The State of Onondaga Lake	2001	Publication	Michalenko, E., Ph.D.	Onondaga Lake Cleanup Corporation	NA	Received
20	A Witches' Brew : A History of Pollution in Onondaga Lake	1992	Master's Thesis	Benton, L. M.	Syracuse University (Geography Department)	NA	Received
21	Onondaga Lake Superfund Review	Winter 1998	Newsletter	Atlantic States Legal Foundation	Atlantic States Legal Foundation	(I): No. 4	Received
22	Public health Assessment, Onondaga Lake, Syracuse, Onondaga County, New York	Jul-95	Report	New York State Department of Health	Under Cooperative Aggreement with the Agency for Toxic Substances and Disease Registry (CERCLIS No. NYD986913580)	NA	Received
23	Onondaga Lake Natural Resource Damage Assessment Plan	Nov-96	Final	Normandeau Associates; Bedford, New Hampshire	NYS DEC	NA	Received
24	Onondaga Wetlands Plan, A Nature Oriented Vision for the Community	Jun-92	Report	Steele, D.	DWS-01A	NA	Received
25	Hydrogeology of the Tully Valley and Characterization of Mudboil Activity, Onondaga County, New York	1996	Report	Kappel, W.M., Sherwood, D.A. and Johnston, W.H	Onondaga Lake Management Conference; U.S. Geological Survey, Water Resources Investigations Report 96-4043	NA	Received
26	Remediation of Mudboil Discharges in the Tully Valley of Central New York	Jan-98	Report	Kappel, W.M. and W. S. McPherson	USGS Fact Sheet	NA	Received
27	Onondaga Lake Watershed, Rural Non point Source Management Plan	May-93	Draft	Esser, A.	Soil Conservation Service	NA	Received
28	Onondaga Lake Non-Point Source Information and Evaluation Program and Best Management Practice Implementation Demonstration	Jun-94	Report	Unknown	Onondaga County Soil & Water Conservation District	NA	Received
29	Vertebrates of Onondaga County, New York, with Notes on Other Taxa	1974	Book	Alexander, M. M.	SUNY-ESF	4th edition	Received
30	OAS Birdathon Results 2003	2003	Website	Onondaga Audubon Society	http://www.onondagaaudubon.org	NA	Received
31	NYS Breeding Bird Atlas	2003	Website	New York State Department of Environmental Conservation	New York State Natural Heritage Program	NA	Received
32	NYS Amphibian and Reptile Atlas Project, 1990-1999	2003	Website	New York State Department of Environmental Conservation	http://www.dec.state.ny.us	NA	Received
33	Checklist of Amphibians, Reptiles, Birds and Mammals of New York State, Including Their Protective Status	1993	Publication	New York State Department of Environmental Conservation	Division of Fish and Wildlife, Endangered Species and Non-Game/Habitat Units, Wildlife Resources Center	NA	Received

Notes:
NA-Reference was reviewed but was not cited in the text

TABLE 1:
SUMMARY OF LITERATURE REVIEWED
ONONDAGA LAKE HABITAT RESTORATION

No.	Title	Date	Type	Author	Agency/Source	Issue (I) Volume (V)	Status
34	Brushing Off Erosion	May-98	Publication	Sotir, R.	CE News	NA	Received
35	Rapid Watershed Planning Handbook-A Comprehensive Guide for Managing Urbanizing Watersheds	Oct-98	Report	Center for Watershed Protection, Ellicott City, Maryland	USEPA, Office of Wetlands, Oceans and Watersheds and Region V	NA	Received
36	Ecological Communities of New York State	1990	Publication	New York State Department of Environmental Conservation	NY Natural Heritage Program	NA	Received
37	Onondaga lake Habitat Improvement Project	2003	Website	EcoLogic	http://www.ecologicllc.com	NA	Received
38	Biological Stream Assessment: Tributaries to Onondaga Lake	1989	Report	Bode, R. W., M. A., Novak, L. E. Abele	NYSDEC	NA	Received
39	Limnological and Engineering Analysis of a Polluted Urban Lake. Prelude to Environmental Management of Onondaga Lake, NY	1996	Book	Effler et al	Springer	NA	Received
40	Wave zone benthic communitites of Onondaga Lake: A Highly Disturbed Aquatic System in Central New York	1998	Thesis	Wagner, B.	SUNY-ESF	NA	Received
41	Assessment of the Status of the Fish Community of Onondaga Lake in 2001, Onondaga Lake 2001 Fish Monitoring Program	2002	Report	Beak and EcoLogic	Onondaga County Department of Water Environment Protection	NA	Received
42	Reproduction and Recruitment of Fishes in a Hypereutrophic Lake (Onondaga Lake, NY)	1998	Thesis	Arrigo	SUNY-ESF	NA	Received
43	Onondaga Lake 2000 Fish Monitoring Program	2001	Report	Ichthylogical Associates and Ecologic	Onondaga County Department of Water Environment Protection	NA	Received
44	Unknown	1992	Unknown	Madsen et al.,	Unknown	NA	Received
45	Onondaga Lake 2000 Macrophyte Report	2001	Report	EcoLogic	Onondaga County Department of Water Environment Protection	NA	Received
46	Onondaga Lake 2001 Macrophyte Report	2002	Report	EcoLogic	Onondaga County Department of Water Environment Protection	NA	Received
47	Onondaga Lake RI/FS Work Plan	1992	Report	PTI	Unknown	NA	Received
48	Geomorphic, Hdrologic, and Hydraulic Determinants of Fish and Macroinvertebrate Communities in a Small Watershed	1994	Dissertation	Danehy	SUNY-ESF	NA	Received
49	Unknown	2003	Report	EcoLogic et al.,	Onondaga County Department of Water Environment Protection	NA	Received
50	Onondaga Lake RI/FS Data Summary Report	1994	Report	PTI	Unknown	NA	Received

Notes:
NA-Reference was reviewed but was not cited in the text

TABLE 1:
SUMMARY OF LITERATURE REVIEWED
ONONDAGA LAKE HABITAT RESTORATION

No.	Title	Date	Type	Author	Agency/Source	Issue (I) Volume (V)	Status
51	Unknown	1998	Unknown	Kappel and McPherson	Unknown	NA	Received
52	Suitability of Nine Mile Creek, New York for Restoratioin of Atlantic Salmon (*Salmo salar*)	1991	Thesis	Murphy, M.	SUNY-ESF	NA	Received
53	Unknown	1989	Unknown	NYSDEC	Unknown	NA	Received
54	A Guidebook for Application of Hydrogeomorphic Assessments to Riverine Wetlands	Dec-95	Technical Report: WRP-DE-11	Brinson, M. M., R. D. Rheinhardt, F. R. Hauer, L. C. Lee, W. L. Nutter, R. D. Smith, D. Whigham	USACE	NA	Received
55	Unified Federal Policy for a Watershed Approach to Federal Land and Resource Management	Oct-00	Notice	Federal Register	Department of Agriculture, Department of Commerce, Office of the Secretary, Natioinal Oceanic And Atmoshpheric Adminsitration, Department of Defense, Department of Energy, Department of the Interior, Environmental Protection Agency, Tennessee Valley Authority, USACE	(v) 65, No. 202	Received
56	Wildlife Community Habitat Evaluation Using a Modified Species-Area Relationship	Jul-96	Technical Report: WRP-DE-12	Schroeder, R.I L. (Natioinal Biological Service)	USACE	NA	Received
57	New York Guidelines for Urban Soil Erosion & Sediment Controls	1997	Publication	NY Guidance for Urban Soil Erosion and Sediment Control Committee	Empire State Chapter Soil and Water Conservation Society	NA	Received
NA	Biological Studies of Onondaga Lake and Tributaries, Report to the Technical Committee of the Onondaga Lake Management Conference	Mar-91	Report	Ringler, R.H.., Gandino, C., Murphy, M., Danehy, R., and Kennen, J.	SUNY-ESF	NA	Received
NA	Geddes Brook/Nine Mile Creek, Human Health Assessment, Onondaga Lake Project	Jul-03	Report	TAMS Consultants, Inc. and YEC, Inc.	New York State Department of Environmental Conservation	(v) 1 of 2 (Text, Tables, Figures, Appendices A-C)	Received
NA	The role of Phragmites Communis in the Transport of Mercury from Onondaga Lake Sediments: Syracuse, N.Y.	1977	Master's Thesis	Kozuchowski, Jack S	SUNY-ESF	NA	Received
NA	Ecological Status of Onondaga Creek in Tully Valley, NY - Summer 1998	1999	Report	USGS	USGS Fact Sheet	NA	Received

Notes:
NA = Not applicable

Notes:
NA-Reference was reviewed but was not cited in the text

TABLE 2: SUMMARY OF ANALYTICAL AND GIS DATA
ONONDAGA LAKE HABITAT RESTORATION

Topic	Tributary	Agency/Source	Focus Area	Dates Covered	Parameter / Species	Format	Status	Other Notes
Hydrography	Onondaga Creek	USGS / NHD	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
		SUNY-ESF	*unknown*	2002-current	*NA*	*unknown*	Not Yet Obtained	
	Harbor Brook	USGS / NHD	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
	Ley Creek	USGS / NHD	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
	Nine Mile Creek	USGS / NHD	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
	Bloody Brook	USGS / NHD	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
	Sawmill Creek	USGS / NHD	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
	Tributary 5A	USGS / NHD	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
	East Flume	USGS / NHD	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
	Lake shoreline	USGS / NHD	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
Aquatic Biota (fish/invertebrates)	Onondaga Creek	NYSDEC	8 sites	1989, 1998, 2002	fish	Excel spreadsheet	Received	
		OCDWEP	four sites	1998- present	invertebrates	AMP report	Received	
		PTI	mouth	1992	fish	Data Summary Report	Not Yet Obtained	
	Harbor Brook	NYSDEC	5 sites	Fall 1997	fish	Excel spreadsheet	Received	
		OCDWEP	three sites	1998 - present	invertebrates	AMP report	Received	
		PTI	mouth	1992	fish	Data Summary Report	Not Yet Obtained	
	Ley Creek	NYSDEC	Park Street	Spring 1989	fish	Excel spreadsheet	Received	
		OCDWEP	three sites	1998- present	invertebrates	AMP report	Received	
		PTI	mouth	1992	fish	Data Summary Report	Not Yet Obtained	
		OBG	near GM	1990s	*unknown*	Ecological Risk Assessment for GM	Not Yet Obtained	May be available
	Nine Mile Creek	NYSDEC	Geddes (2 locations)	1989, 1990	fish	Excel spreadsheet	Received	
		NYSDEC	Camillus, Marcellus	1990, 1996	fish	Excel spreadsheet	Received	
		OCDWEP	*unknown*	2000-2002	invertebrates	AMP report	Received	
		Murphy	Camillus-Otisco Lake	1990	fish community; IBI, HIS	thesis	Received	
		Ruby SUNY-ESF	Marcellus Falls	1992	invertebrates	term paper	Not Published	May be available
		PTI	mouth	1992	fish	Data Summary Report	Not Yet Obtained	available at OCPL
	Bloody Brook	PTI	mouth	1992	fish	Data Summary Report	Not Yet Obtained	available at OCPL
	Sawmill Creek	PTI	mouth	1992	fish	Data Summary Report	Not Yet Obtained	available at OCPL
	Tributary 5A	PTI	upstream of culvert to lake	1992	fish	Data Summary Report	Not Yet Obtained	available at OCPL
	East Flume	PTI	mouth	1992	fish	Data Summary Report	Not Yet Obtained	available at OCPL
	Lake shoreline	NYSDEC	various areas around lake	1989-2002	fish	Excel spreadsheet	Received	
		OCDWEP	various areas around lake	2000-2002	littoral fish; fish nest counts	AMP report	Received	
		PTI	8 areas around lake	1992	fish	Data Summary Report	Not Yet Obtained	available at OCPL
		Gandino	various areas around lake	1990s	fish	thesis	Not Yet Obtained	available at ESF
		Arrigo	various areas around lake	1990s	fish/plants	thesis	Not Yet Obtained	available at ESF
		Wagner	various areas around lake	1990s	invertebrates	thesis	Not Yet Obtained	available at ESF
		Tango	various areas around lake	1990s	fish	dissertation	Not Yet Obtained	available at ESF

TABLE 2: SUMMARY OF ANALYTICAL AND GIS DATA
ONONDAGA LAKE HABITAT RESTORATION

Topic	Tributary	Agency/Source	Focus Area	Dates Covered	Parameter / Species	Format	Status	Other Notes
Water Quality	Onondaga Creek	PTI/TAMS	near mouth	1992	pH, temp, DO, cond, flow, TSS, TOC, TIC, NH3, CL, SO4; Metals, Hg, VOCs, HCB	Onondaga Lake RI	Received	
		OCDWEP	Spencer St and Dorwin Ave	Early 1990s - present	salinity, pH, temp, cond, DO, Redox, metals, nutrients, phenols, TSS, TOC, TIC,	AMP Reports	Received	
		USGS	Tully Valley	1990s (?)	*unknown*	Mud Boil Study	Not Yet Obtained	May be available
	Harbor Brook	PTI/TAMS	near mouth	1992	pH, temp, DO, cond, flow, TSS, TOC, TIC, NH3, CL, SO4; Metals, Hg, VOCs, HCB	Onondaga Lake RI	Received	
		OCDWEP	Hiawatha Blvd & Velasko Rd	Early 1990s - present	salinity, pH, temp, cond, DO, Redox, metals, nutrients, phenols, TSS, TOC, TIC,	AMP Reports	Received	
	Ley Creek	PTI/TAMS	near mouth	1992	pH, temp, DO, cond, flow, TSS, TOC, TIC, NH3, CL, SO4; Metals, Hg, VOCs, HCB	Onondaga Lake RI	Received	
		OCDWEP	Park Street	Early 1990s - present	salinity, pH, temp, cond, DO, Redox, metals, nutrients, phenols, TSS, TOC, TIC,	AMP Reports	Received	
		OBG	near GM	1990s	*unknown*	Ecological Risk Assessment for GM	Not Yet Obtained	May be available
	Nine Mile Creek	PTI/TAMS	State Fair Blvd / Route 5	1992	pH, temp, DO, cond, flow, TSS, TOC, TIC, NH3, CL, SO4; Metals, Hg, VOCs, HCB	Onondaga Lake RI	Received	
		OCDWEP	Lakeland	Early 1990s - present	salinity, pH, temp, cond, DO, Redox, metals, nutrients, phenols, TSS, TOC, TIC,	AMP Reports	Received	
	Bloody Brook	PTI/TAMS	near mouth	1992	pH, temp, DO, cond, flow, TSS, TOC, TIC, NH3, CL, SO4; Metals, Hg, VOCs, HCB	Onondaga Lake RI	Received	
	Sawmill Creek	PTI/TAMS	near mouth	1992	pH, temp, DO, cond, flow, TSS, TOC, TIC, NH3, CL, SO4; Metals, Hg, VOCs, HCB	Onondaga Lake RI	Received	
	Tributary 5A	PTI/TAMS	near mouth	1992	pH, temp, DO, cond, flow, TSS, TOC, TIC, NH3, CL, SO4; Metals, Hg, VOCs, HCB	Onondaga Lake RI	Received	
	East Flume	PTI/TAMS	near mouth	1992	pH, temp, DO, cond, flow, TSS, TOC, TIC, NH3, CL, SO4; Metals, Hg, VOCs, HCB	Onondaga Lake RI	Received	
		OCDWEP	one location	Early 1990s - present	salinity, pH, temp, cond, DO, Redox, metals, nutrients, phenols, TSS, TOC, TIC,	AMP Reports	Received	
	Lake shoreline	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	
	Onondaga Creek	NRCS / STATSGO	entire subwatershed	*unknown*	NA	GIS data layer	Received	
		Coyle M.S. thesis	entire subwatershed	1977	*NA*	paper copy only	Received	Assessing electronic availability
	Harbor Brook	NRCS / STATSGO	entire subwatershed	*unknown*	*NA*	GIS data layer	Received	
		Coyle M.S. thesis	entire subwatershed	1977	*NA*	paper copy only	Received	
	Ley Creek	NRCS / STATSGO	entire subwatershed	*unknown*	*NA*	GIS data layer	Received	

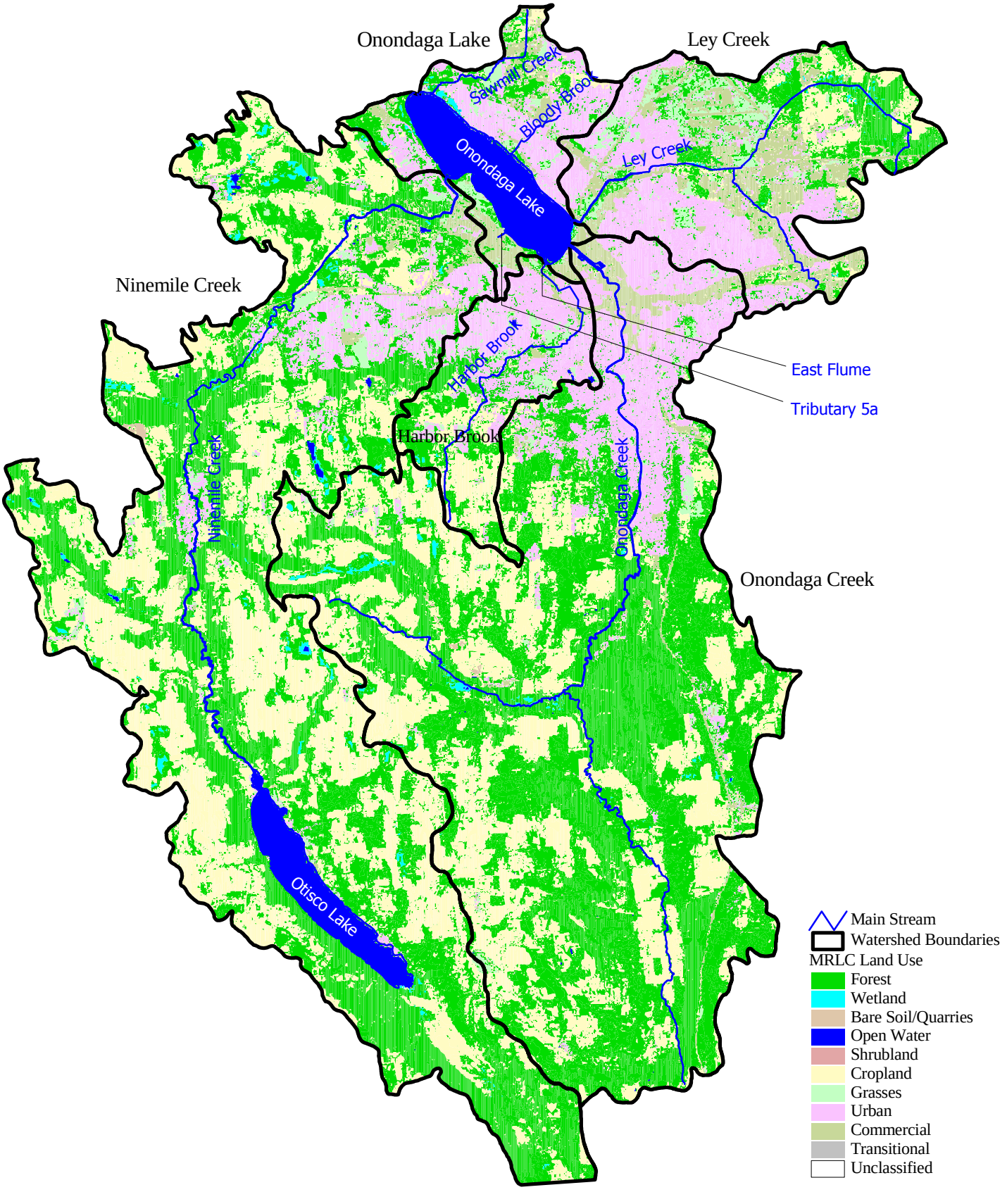
TABLE 2: SUMMARY OF ANALYTICAL AND GIS DATA
ONONDAGA LAKE HABITAT RESTORATION

Topic	Tributary	Agency/Source	Focus Area	Dates Covered	Parameter / Species	Format	Status	Other Notes
Substrate/ Soils	Ley Creek	Coyle M.S. thesis	entire subwatershed	1977	*NA*	paper copy only	Received	
	Nine Mile Creek	NRCS / STATSGO	entire subwatershed	*unknown*	*NA*	GIS data layer	Received	
		Murphy M.S. thesis	Camillus to Otisco Lake	substrate data	*NA*	paper copy only	Received	
		Coyle M.S. thesis	entire subwatershed	1977	*NA*	paper copy only	Received	
	Bloody Brook	NRCS / STATSGO	entire subwatershed	*unknown*	*NA*	GIS data layer	Received	
		Coyle M.S. thesis	entire subwatershed	1977	*NA*	paper copy only	Received	
	Sawmill Creek	NRCS / STATSGO	entire subwatershed	*unknown*	*NA*	GIS data layer	Received	
		Coyle M.S. thesis	entire subwatershed	1977	*NA*	paper copy only	Received	
	Tributary 5A	NRCS / STATSGO	entire subwatershed	*unknown*	*NA*	GIS data layer	Received	
		Coyle M.S. thesis	entire subwatershed	1977	*NA*	paper copy only	Received	
	East Flume	NRCS / STATSGO	entire subwatershed	*unknown*	*NA*	GIS data layer	Received	
		Coyle M.S. thesis	entire subwatershed	1977	*NA*	paper copy only	Received	
	Lake shoreline	Coyle M.S. thesis	entire subwatershed	1977	*NA*	paper copy only	Received	
Land Use	Onondaga Creek	MRLC	entire subwatershed	early 1990s	*NA*	GIS data layer	Received	
	Harbor Brook	MRLC	entire subwatershed	early 1990s	*NA*	GIS data layer	Received	
	Ley Creek	MRLC	entire subwatershed	early 1990s	*NA*	GIS data layer	Received	
	Nine Mile Creek	MRLC	entire subwatershed	early 1990s	*NA*	GIS data layer	Received	
	Bloody Brook	MRLC	entire subwatershed	early 1990s	*NA*	GIS data layer	Received	
	Sawmill Creek	MRLC	entire subwatershed	early 1990s	*NA*	GIS data layer	Received	
	Tributary 5A	MRLC	entire subwatershed	early 1990s	*NA*	GIS data layer	Received	
	East Flume	MRLC	entire subwatershed	early 1990s	*NA*	GIS data layer	Received	
	Lake shoreline	MRLC	entire subwatershed	early 1990s	*NA*	GIS data layer	Received	
Wetlands/ Riparian Areas	Onondaga Creek	NYSDEC	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
		NWI	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
	Harbor Brook	NYSDEC	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
		NWI	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
	Ley Creek	NYSDEC	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
		NWI	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
	Nine Mile Creek	NYSDEC	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
		NWI	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
	Bloody Brook	NYSDEC	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
		NWI	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
	Sawmill Creek	NYSDEC	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
		NWI	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
	Tributary 5A	NYSDEC	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
		NWI	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
	East Flume	NYSDEC	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
		NWI	entire subwatershed	*NA*	*NA*	GIS data layer	Received	
	Lake shoreline	SUNY-ESF	*NA*	1992	*NA*	Report	Received	Authors: Vandruff and Pike
		OCDWEP	lake	1998-present	macrophyte coverage	AMP Report	Received	
	Onondaga Creek	USGS / DEM	entire subwatershed	*unknown*	*NA*	GIS data layer	Received	
	Harbor Brook	USGS / DEM	entire subwatershed	*unknown*	*NA*	GIS data layer	Received	
	Ley Creek	USGS / DEM	entire subwatershed	*unknown*	*NA*	GIS data layer	Received	
	Nine Mile Creek	USGS / DEM	entire subwatershed	*unknown*	*NA*	GIS data layer	Received	

TABLE 2: SUMMARY OF ANALYTICAL AND GIS DATA
ONONDAGA LAKE HABITAT RESTORATION

Topic	Tributary	Agency/Source	Focus Area	Dates Covered	Parameter / Species	Format	Status	Other Notes
Topography	Bloody Brook	USGS / DEM	entire subwatershed	*unknown*	*NA*	GIS data layer	Received	
	Sawmill Creek	USGS / DEM	entire subwatershed	*unknown*	*NA*	GIS data layer	Received	
	Tributary 5A	USGS / DEM	entire subwatershed	*unknown*	*NA*	GIS data layer	Received	
	East Flume	USGS / DEM	entire subwatershed	*unknown*	*NA*	GIS data layer	Received	
	Lake shoreline	USGS / DEM	entire subwatershed	*unknown*	*NA*	GIS data layer	Received	

Notes:
NA = Not applicable



N

1 0 1 2 3 Miles

Figure 1. Onondaga Lake Watershed

Note: Labels in black indicate name of each major subwatershed.

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SECTION 2

DATA COLLECTION AND REVIEW

2.1 HABITAT RESTORATION VARIABLES

This section summarizes the findings of the literature review and identifies potential data gaps required to develop a Comprehensive Habitat Restoration Plan. The Architect-Engineer (A-E) Team will continue to review new information and data sources as they become available. This section describes the following watershed variables that pertain to the condition of the habitats within the watershed: aquatic resources, vegetated buffers and wetlands, wildlife, and threatened and endangered species. This section also provides a summary of guidance documents for habitat restoration in watersheds.

2.1.1 Aquatic Resources

Aquatic resources, including fish, benthic invertebrates, water quality, and habitat quality, have been assessed within the Onondaga Lake watershed over the past 25 years. Onondaga Lake and its major tributaries including Onondaga Creek, Nine Mile Creek, Ley Creek, and Harbor Brook have attracted the most attention, with limited studies being conducted on the smaller tributaries (Sawmill Creek, Bloody Brook, Tributary 5A and the East Flume).

As part of the ACJ, Onondaga County is required to conduct an extensive monitoring program for physical (i.e., riparian vegetation), chemical (i.e., pH, dissolved oxygen, temperature), and biological (i.e., fish, plankton, and macroinvertebrates) conditions in the surface water resources under the AMP. The purpose of this program is to estimate annual external loadings of chemicals, sediments, bacteria, etc. to the lake via its tributaries as well as evaluate trends in water quality in response to pollution prevention and remediation efforts in the surrounding watershed. Detailed information for each tributary can be found in the annual reports put out by the county's OCDWEP.

In June 1989, the Stream Biomonitoring Unit of the NYSDEC Division of Water conducted a biological survey. The goal of the survey was to assess the existing water quality conditions of the six natural tributaries as reflected in the resident macroinvertebrate populations (i.e. aquatic insects, worms, mollusks, crustaceans, etc.) (Reference 37). The survey found that pollutant tolerant worms, midges, and sowbugs dominated within the mouths of the tributaries regardless of the quality of the physical habitat suggesting that species abundance and diversity was controlled by water quality and not physical habitat. In addition, elevated levels of metals were found in invertebrate tissues sampled from Bloody Brook, Ley Creek, Harbor Brook, and Geddes Brook (tributary of Nine Mile Creek) (Reference 37).

The remainder of this section presents a summary of the aquatic resources of the Onondaga Lake watershed by major sub-watershed including Nine Mile Creek, Harbor Brook, Onondaga Creek, and Ley Creek (Figure 1). The smaller tributaries including Sawmill Creek, Bloody

Brook, Tributary 5A, and East Flume have been grouped for discussion. The summary of available data is presented in tabular format in Table 2.

Lake Shoreline

The fish community of Onondaga Lake has changed over the past 75 years from a cold-water fishery (Atlantic salmon (*Salmo salar*) and Onondaga Lake whitefish (presumed to be a cisco, (*Coregonus* spp.)) to a warm-water fishery dominated by carp (*Cyprinus carpio*), gizzard shad (*Dorosoma cepedianum*), white perch (*Morone americana*), white sucker (*Catostomus commersoni),* yellow perch (*Perca flavescens*), bluegill sunfish (*Lepomis macrochirus*), and pumpkinseed sunfish (*L. gibbosus)* (Reference 39). A fish survey performed in 2000 and 2001 as part of the AMP, documented 34 fish species within Onondaga Lake of which 12 to 18 species were larval fish dominated by carp, gizzard shad, and sunfish species (References 41 and 43). The benthic invertebrate community along the Onondaga Lake shoreline is dominated by pollution tolerant species of chironomids and oligochaetes (Reference 40).

The study conducted by Beak and EcoLogic (2002) also found that 92% of fish nests were located in the northern basin in 2000, and all nests were located in the northern basin in 2001. Fish species observed on these nests included largemouth bass (*Micropterus salmoides*), smallmouth bass (*M. dolmieui*), bluegill sunfish and pumpkinseed sunfish. Smallmouth bass nesting activity was first documented in Onondaga Lake in 2000. The extreme southern end of the lake has had a scarcity of nests during the previous nest surveys (References 41, 42 and 43). Oncolites and wave energy in the littoral zone of the southern basin of the lake create an unsuitable habitat for fish nesting, limiting the area available for spawning activities to the northern basin of the lake (Beak and EcoLogic, 2002).

Limited growth of rooted aquatic plants (i.e. macrophytes) in Onondaga Lake has been linked to the character of the near shore sediments. The littoral sediments within much of the lake are dominated by oncolites which are ovoid calcium carbonate concretions ranging from less than one centimeter to several centimeters in diameter. Oncolites are believed to have formed in response to the ionic discharges from the former soda ash facility (Reference 19). Oncolites along the littoral zone limit vegetative growth due to the inherent instability of the substrate in combination with high wave energies. This scarcity of rooted vegetation limits the populations and variety of aquatic species found in the lake since they provide shelter for juvenile fish and consequently food resources for larger fish.

A macrophyte study conducted by Ecologic (2001) as part of the County AMP program divided the lake into five strata types based on sediment type and wave energy. Strata 1 is located in the northwest and is characterized as an oncolite substrate within a low wave energy environment. Strata 2 is located in the southwest and is characterized as waste bed substrate within a medium wave energy environment. Strata 3 and 4 comprise the southern and southeastern shores. Strata 3, at the southern end of the lake, is characterized as fine sediment substrate within a high-energy environment. Strata 4, along the southeastern shore, is characterized as oncolite substrate within a high-energy environment. Strata 5 is located in the northeast portion of the Lake and is characterized as oncolite substrate within a medium wave

energy environment. The highest concentration of macrophytes was found within Strata 1 and 5 (EcoLogic, 2001).

In the same study ten species of macrophytes were identified in 2000 including nine submersed and one emergent, twice the number identified in studies performed in 1991 (Reference 45). The dominant species of the macrophyte community included sago pondweed (*Potamogeton pectinatus*), American waterweed (*Elodea canadensis*), and water stargrass (*Zosterella dubia*).

Macrophyte species diversity and spatial distribution in the lake have been quantified on several occasions during the past decade (References 44, 45 and 46). These time series data allow for an assessment of the changing character of the macrophyte populations within the lake. Results from the most recent AMP study suggest that the number of macrophyte beds within the lake is growing in size although they currently occupy less than 10% of the littoral zone (Reference 45). In addition, this study found that the population of macrophytes has increased from 13% of the study subplots containing macrophytes in 1991 to 47% of the study plots in 2000. Continued increases in macrophyte distribution within the lake would directly benefit the spawning efforts of resident fish including largemouth bass and northern pike.

Currently, no studies have been identified that characterize water quality along the lake shoreline. Water quality data are collected from the middle of both lake basins by Onondaga County as part of the AMP.

Onondaga Creek

Several studies in Onondaga Creek have documented the fish community, physical habitat, and water quality of the stream, primarily through the City of Syracuse and in the upstream reaches near the Tully mudboils. Current studies include an assessment of the urban areas of the Creek to establish restoration potential and use as a resource for the community along the banks (SUNY-ESF web site).

The fish community of Onondaga Creek is dominated by warm water species (sunfish, bullhead (*Ameiurus nebulosus*)) in the downstream (urban) reaches, with cold-water species (brown trout (*Salmo trutta*)) in the upper (rural) reaches (References 47, 48 and NYSDEC database (see Table 2)). Invertebrate sampling has been conducted in 2000 and 2002 as part of the Onondaga County AMP at four locations (Spencer Street, Dorwin Avenue, Webster Road, and Tully Farms Road). Results of this study during both years indicated that invertebrates collected at Spencer Street were moderately to severely impacted due to water quality and habitat degradation. Invertebrate populations within the vicinity of Dorwin Avenue and Webster Road were characterized as slightly impacted, while the populations within the vicinity of Tully Farms Road were characterized as unimpacted.

Detailed water quality data, collected as part of the Onondaga County AMP tributary monitoring program are available for the urban portion of Onondaga Creek from Dorwin Avenue downstream to the lake (Reference 49). Water quality data were also collected from the urban portion of the creek in 1992 as part of the remedial investigation (RI) for Onondaga Lake (Reference 50).

The physical habitat of Onondaga Creek within the City of Syracuse, is highly degraded with numerous channelized areas and impaired riparian habitat. This tributary has been severely impacted by excessive sedimentation from the Tully Valley mudboils located in the upper reaches of the creek resulting in limited habitat for fish species. In 1992, the USGS implemented a remedy that reduced the sediment load from the mudboils to Onondaga Creek from approximately 30 tons per day to 10 tons per day (Reference 51). From 1994 through 1996, sediment loading from the mudboils to Onondaga Creek was further reduced to approximately 1.4 -3.0 tons per day (Reference 51).

Nine Mile Creek

Studies have been conducted on Nine Mile Creek to assess fish and invertebrate community structure and physical habitat along the entire stretch of the river. Nine Mile Creek flows out of Otisco Lake and drains to Onondaga Lake (References 50 and 52). The upper reaches of the creek are dominated by warm water fish species including smallmouth bass, chain pickerel (*Esox niger*), and sunfish (*Lepomis* spp.) However, brown trout, a cold-water species, are stocked annually in these reaches for a put and take fishery by the Carpenters Brook Fish Hatchery (Onondaga County).

The mid-section of the creek (near Marcellus Falls) receives groundwater inputs that maintain a lower temperature than the upstream reaches. Consequently, the area below Marcellus Falls is prime trout habitat and receives considerable fishing pressure. The lower (urban) reaches are impacted by industrial waste beds with highly degraded habitat and, consequently an impacted fish and invertebrate community (M. H. Murphy – personal observation).

Detailed water quality data, collected as part of the Onondaga County AMP are available from the town of Camillus downstream to the mouth of the tributary. Limited water quality data are available upstream of Camillus.

Ley Creek

Fish community studies in Ley Creek are limited to three: one at the mouth of Ley Creek (Reference 50), one sampling assessment above the bridge at Park Street (Reference 53), and an assessment conducted as part of the General Motors ecological risk assessment (document not yet received). Only two fish were collected in the mouth of Ley Creek during the 1992 assessment (Reference 50).

Invertebrate samples were collected in 2000 and 2002 from three locations along Ley Creek (Park Street, 7th North Street, and Townline Road) as part of the AMP Results of these surveys indicated that invertebrates collected at all three locations were moderately impacted due to water quality and habitat degradation during 2000, and severely impacted during 2002. Detailed water quality data, collected as part of the AMP are available for the lower sections of Ley Creek (available from early 1990s). No data on biota, water quality, and physical habitat have been identified for the upper reaches of this tributary.

Harbor Brook

Onondaga County collects invertebrate samples from three locations on Harbor Brook (Route 690, Hiawatha Boulevard, and Velasko Road) as part of the AMP program. Invertebrates collected at Route 690 were moderate to severely impacted in both 2000 and 2002. Similarly, invertebrates collected at Hiawatha Boulevard were severely impacted during both years of sampling, while samples collected at Velasko Road were severely impacted in 2000, but moderately impacted in 2002. There is only one record of fish data identified at the mouth of Harbor Brook (Reference 50). Very few fish were collected during this study and the catch was dominated by pumpkinseed and bluegill sunfish.

Detailed water quality data are collected at Hiawatha Boulevard and Velasko Road as part of the Onondaga County AMP. These data are available from the early 1990 to the present.

No information or data was identified to characterize the physical in-stream habitat of this tributary.

Minor Tributaries

One of the few studies (Reference 50) completed for Sawmill Creek, Bloody Brook, Tributary 5A, and the East Flume was a fish survey that identified community structure at the mouths of each tributary. Only two individuals were collected from Tributary 5A, while the other three streams contained several species including sunfish, fathead minnows (*Pimephales promelas*), and central mudminnow (*Umbra limi*). Currently there is a remedial investigation/feasibility study (RI/FS) being conducted under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) that include an assessment of Bloody Brook contaminants originating from a nearby industrial plant. However, no data from this study are yet available.

Water quality data have been collected from Tributary 5A and the East Flume as part of the Onondaga County AMP. In addition water quality data were collected near the mouth of each sub-basin as part of the RI for Onondaga Lake (Reference 50). Parameters measured included: metals, nutrients, temperature, dissolved oxygen, pH, and alkalinity. Studies involving vegetation within each tributary have not been completed. Tributary 5A and the East Flume are being assessed as part of the Onondaga Lake Superfund site.

2.1.2 Vegetated Buffers and Wetlands

Existing information was reviewed to develop an understanding of the state of the vegetated buffers and wetlands within the Onondaga Lake watershed to assess the area's current ability and/or future potential to support fish and wildlife.

Vegetated Buffer Resources

The Onondaga Lake watershed contains two vegetation zones: the Appalachian Plateau and the Ontario Plains region (Reference 5). The Appalachian Plateau lies to the south and is dominated by northern deciduous forests characterized by the presence of sugar maple (*Acer saccharum*), beech (*Fagus grandifolia*), yellow birch (*Betula alleghaniensis*), and hemlock

(*Tsuga canadensis*). The Ontario plains region lies to the north and is dominated by southern deciduous forests characterized by the presence of oaks (*Quercus* spp.), hickories (*Carya* spp.), tulip tree (*Liriodendron tulipifera*), sassafras (*Sassafras albidum*), and American sycamore (*Platanus occidentalis*). Presently, there are no virgin wooded areas in Onondaga County (Reference 6). Clearing of these wooded areas for various land use purposes caused fragmentation of natural communities and a loss of biodiversity however, much of the area has since regrown.

Plant species diversity within the Onondaga Lake area was reviewed in 1961 and 1992 (References 5 and 7). Onondaga County was found to support a diversity of plant biota. The 1961 summary of plants in the County listed 126 plant families, including 598 genera, 1622 species, and 1662 subspecies or varieties. A key to the woody species of Onondaga County was also published in 1973 that documents 353 woody species as existing in the area (Reference 6). The species list was not updated in the 1992 review; however, the report does discuss the reversion of portions of former industrial sites along the lake to shrub-scrub areas.

Land use in the watershed is a mixture of urban areas (22%), forests (43%), and agriculture (32%) (Reference 8). The headwaters of Nine Mile Creek, Harbor Brook, Onondaga Creek, Sawmill Creek, and portions of Ley Creek lie within rural areas; whereas, the headwaters of Tributary 5A, the East Flume, and Bloody Brook lie almost entirely within urban areas (Reference 9). Except for narrow fringes of open field, brush, or wooded areas, urban areas surround the entire lake and the lower drainage basins of all the tributaries (Reference 6 and personal observation).

Land use information for the Onondaga Lake watershed was published in 2001 for Harbor Brook, Ley Creek, Nine Mile Creek, Onondaga Creek, and Onondaga Lake (Reference 8). Additional information is available for the lake and all the tributaries using the Multi-Resolution Land Use/Land Cover GIS data identified in Table 2. United States Geological Survey (USGS) topographical maps show that the land is predominantly rural outside of the Onondaga watershed (Reference 9).

Vegetation cover has been widely surveyed around the perimeter of the lake and in the lower portions of Nine Mile Creek, Tributary 5A, the East Flume, Harbor Brook, Onondaga Creek, and Ley Creek (References 5, 10, 11, 12, 13, 14, and 15). Seven major types of upland habitat are associated with the lake shoreline: parkland, former industrial waste beds (in various stages of regrowth), rock shoreline, open shoreline, open field, successional shrubland, and cottonwood-dominated floodplain.

Direct information regarding the vegetated buffer communities bordering the remaining lengths of the tributaries is generally unavailable, but may be deduced indirectly from aerial photographs, land use/land cover maps, and soil survey maps.

Wetland Resources

NYSDEC Freshwater Wetland Maps and Federal National Wetland Inventory Maps were reviewed to identify existing state and federal wetland boundaries within the watershed. The maps show that numerous state and federal wetlands exist along the Onondaga Lake tributary

stream corridors. Wetlands number the greatest in the rural sections of the County and decrease toward the urban areas of Greater Syracuse. The wetland maps and USGS topographical maps indicate that portions of Sawmill Creek, Bloody Brook, and Harbor Brook likely are culverted underground within portions of the urban area.

Most of the wetlands in Onondaga County have not been studied in detail. However, thirty-three of the major natural wetland areas in Onondaga County have been characterized. These major wetlands were found to be of five types: inland shallow freshwater marshes, inland deep freshwater marshes, inland open fresh water, shrub swamps, and wooded swamps (Reference 16).

In contrast, wetlands surrounding Onondaga Lake have been evaluated during numerous studies (References 5, 10, 11, 12, 13, 14, and 15). Five types of wetland habitat were found to be associated with the lake: mudflats, a silver maple (*Acer saccharinum*)-ash swamp, a perched swamp white oak (*Quercus alba*) swamp, emergent wetlands, and common reed (*Phragmites australis*)/purple loosestrife (*Lythrum salicaria),* marshes (Reference 5). Although the lands south of Onondaga Lake were formerly occupied by an extensive swamp system they were drained and filled in by waste material from the Solvay Process in the late 1890s (Reference 17). Only a narrow fringe of silver maple-ash swamp and common reed marsh now exist at the southern end of the lake today (Reference 10 and personal observation).

2.1.3 Wildlife

Lumbering, agriculture, industrialization, and urbanization have resulted in extensive alteration of the landscape and the land's ability to support diverse biota. Some wildlife, such as wolves, bears, and bobcats, have long been extirpated from central New York and the Onondaga Lake area. The loss of large tracts of forest and wetlands over the last 100 years has resulted in the fragmentation of natural communities (Reference 5). The greater Syracuse urbanized area that surrounds Onondaga Lake and the lower watershed basin has been particularly fragmented by the presence of canals, railroads, highways, streets, residential areas, and urbanized areas (Reference 9).

A list of vertebrates that inhabit Onondaga County was developed in 1974 (Reference 5 and 29). The list of vertebrates includes 20 species of amphibians, 19 species of reptiles, 264 species of birds, and 52 species of mammals. In addition, the Onondaga Environmental Management Council estimated that 50 to 60 mammalian species were present in Onondaga County in 1975 (Reference 5). The Onondaga Audubon Birdathon, recorded 194 species of birds in the County in 2003 (Reference 30). Other sources of information on Onondaga County species include the New York State Breeding Bird Atlas (Reference 31), the New York State Amphibian and Reptile Atlas Project (Reference 32), and the New York State DEC checklist of wildlife in New York State (Reference 33). Several studies have looked at species present around Onondaga Lake (References 5, 10, 11, 12, 13, 14, and 15).

Baseline Ecological Risk Assessments (BERA) have been conducted for several Onondaga Lake Superfund Sites. For example, BERAs have been performed as part of the remedial investigation for Onondaga Lake and Geddes Brook/ Nine Mile Creek. Although the results

from the BERAs will not be discussed in this report, they will be evaluated later and used to develop the CHRP.

2.1.4 Threatened and Endangered Species

Letters have been sent to the US Fish & Wildlife Service and the NYSDEC Natural Heritage Program, in order to obtain up-to-date information regarding the presence or absence of threatened and endangered species or rare plant communities at Onondaga Lake or along the stream corridors of Nine Mile Creek, Tributary 5A, the East Flume, Harbor Brook, Onondaga Creek, Ley Creek, Bloody Brook, and Sawmill Creek. The presence of threatened and endangered species in a candidate restoration area may place constraints on the design of the restoration proposal in that area. However, the presence of such species can also offer opportunities to re-establish appropriate habitat such that these species can be sustained. Threatened and endangered species data will be presented within and utilized during the development of the Identification of General Habitat Restoration Goals Report (next task).

2.2 STRATEGIES AND TECHNOLOGIES

Well-vegetated lands surrounding open water environments (i.e., lakes, streams) play an important role in watershed protection. The guidance given by the USACE (References 1 and 2) states those vegetative buffers next to streams and open waters provide the following functions:

- Reduce adverse effects to water quality by removing nutrients and pollutants from surface runoff;
- Reduce concentrations of nutrients and pollutants in subsurface water that flows into streams and other open waters;
- Moderate storm flows to streams by providing flood storage capacity, which reduces downstream flooding and degradation of aquatic habitat;
- Stabilize soil (through plant roots), which reduces erosion in the vicinity of the open water body;
- Provide shade to the water body, which moderates water temperature changes and provides a more stable aquatic habitat for fish and other aquatic organisms;
- Provide detritus, which is a food source for many aquatic organisms;
- Provide large woody debris from riparian zones, which furnishes cover and habitat for aquatic organisms and may cause the formation of pools in the stream channel;
- Provide habitat to a wide variety of aquatic and terrestrial species;
- Trap sediments, thereby reducing degradation of the substrate that provides habitat for fish and other aquatic organisms (i.e., some fish species depend upon gravel stream beds for spawning habitats); and
- Provide corridors for movement and dispersal of many species of wildlife.

In a similar manner, vegetated wetlands, when present along lakes and stream corridors of a watershed are recognized by the USACE in its Section 404 permit process to provide the following functions and values (Reference 3):

- Ground water recharge and discharge;
- Flood flow alteration;
- Fish and shellfish habitat;
- Sediment/ toxicant/ pathogen retention;
- Nutrient removal/retention/ transformation;
- Production export;
- Sediment/ shoreline stabilization;
- Wildlife habitat;
- Recreation;
- Education/ scientific value;
- Uniqueness/ heritage;
- Visual quality/ aesthetics; and
- Habitat for threatened and endangered species.

Watersheds often lack adequate vegetated buffers and wetlands around lakes and tributaries due to urban development, residential development, infrastructure improvements, and agricultural practices. Restoring the functions of these vegetated buffers and wetlands is the strategy that will provide corridors for the movement and dispersal of wildlife throughout a watershed, improve in stream fish habitat, and enhance and protect water quality in the watershed.

One method for habitat restoration within watersheds starts at the headwaters of the watershed and proceeds downstream toward the lower basins. The top down approach allows wildlife corridors to become established along the streams, thus facilitating the movement of wildlife from adjacent rural areas to move down the corridors and become re-established within the watershed.

Restoring vegetative communities in gaps along the mid basin streams, would allow for continuous corridors from the intact upper watershed areas down to the proposed habitat creations around the lake area. Continuous vegetated transition areas between the water bodies and upland areas, once established, will function to provide high habitat diversity; high biological productivity; a wildlife refuge, a travel corridor; and buffering for the adjacent water body (Reference 34).

Several projects with habitat restoration elements are currently underway in the area around Onondaga Lake. These projects include, though are not limited to, the Lake Trail sections (References 10, 11, and 12); efforts by the Onondaga Lake Cleanup Corporation to improve the

habitat and aquatic plants along the shore of Onondaga Lake (Reference 19); a littoral zone habitat project being carried out by EcoLogic (Reference 37), Onondaga Creek restoration efforts (SUNY-ESF website); Nine Mile Creek habitat improvements (Nine Mile Creek Conservation Agency: information not yet available); and remediation efforts at the Onondaga Lake superfund sites. Restoration sites should be selected such that they will blend with these existing or planned habitat improvement projects.

Many in-stream remedies exist to restore impacted channels to properly functioning fisheries habitat. The goals of stream segment restoration would be the following: control of the hydrologic regime; mitigation of urban pollutants (if possible); restoration of stream habitat; stabilization of channel morphology; augmentation of riparian cover; protestation of stream substrate; and enabling recolonization of native aquatic community. Besides bankside improvements to control bank erosion, in-stream structures, such as low stage check dams, channel constrictors or deflectors, root wads, and brush piles can be placed within the channel to restore slope and sinuosity.

Literature sources have been developed by federal, state and local agencies that provide guidance for the evaluation of habitat restoration measures at the watershed level. These sources will be evaluated during the next project task to develop a systematic approach to identify habitat restoration goals within the Onondaga Lake watershed. Several example guidance documents for watershed habitat restoration are listed below:

- A Guidebook for Application of Hydrogeomorphic Assessments to Riverine Wetlands provides a methodology to adapt from the generalities of the riverine class to specific regional riverine subclasses (Reference 54);
- United Federal Policy for a Watershed Approach to Federal Land and Resource Management provides a framework for a watershed approach to prevent and reduce pollution of surface and ground waters resulting from Federal land and resource management activities in a unified and cost-effective manner (Reference 55);
- Maryland Watershed Planning Handbook provides beneficial guidance for the identification of restorable stream segments based on the surrounding percentage of impervious cover (Reference 35);
- Reschke's study on New York Ecological communities provides guidance for designing wetlands and terrestrial buffer communities using plant assortments that would produce native type ecological communities (Reference 36);
- Wildlife Community Habitat Evaluation Using a Modified Species-Area Relationship provides guidance on using species area relationships to develop wildlife community habitat models (Reference 56);
- New York Guidelines for Urban Erosion & Sediment Controls details acceptable technologies for structural stream bank stabilization and sediment and erosion control in New York State (Reference 57);
- Stream Corridor Restoration provides principles and practices associated with restoring watersheds and stream corridors; and

- Several habitat restoration plans have been developed by other states and cities, which may provide examples of methods that had positive impacts as well as methods that had negative impacts.

SECTION 3

DATA GAPS

The following have been identified as data gaps that may limit the development of a Comprehensive Habitat Restoration Plan:

3.1 AQUATIC RESOURCES

The following data gaps have been identified, which may limit the assessment of aquatic resources for habitat restoration:

- Water quality has not been characterized along the lake shoreline, upstream of Camillus in Nine Mile Creek, and for the upper reaches of Ley Creek;
- Biota have not been identified for the upper reaches of Ley Creek;
- Physical habitat has not been identified for the upper reaches of Ley Creek and Harbor Brook; and
- Vegetation within Sawmill Creek, Bloody Brook, Tributary 5A and the East Flume have not been completed.

3.2 VEGETATED BUFFERS AND WETLANDS

The following data gaps have been identified, which may limit the assessment of vegetated buffers and wetlands components for habitat restoration:

- Direct information regarding the vegetated buffer communities bordering the remaining lengths of the tributaries is generally unavailable, but may be deduced indirectly from aerial photographs, land use/land cover maps, and soil survey maps;
- Information on specific locations within the watershed impacted by soil erosion and/or bank erosion such as Nine Mile Creek; and
- Most of the wetlands in Onondaga County have not been specifically studied; however, most major wetlands have been identified on federal NWI maps or State DEC freshwater wetlands maps.

3.3 WILDLIFE

The following data gaps have been identified, which may limit the assessment of wildlife for habitat restoration:

- Wildlife specific to each subwatershed of the Onondaga watershed basin has not been inventoried. However, this data gap is not expected to inhibit the development of a Comprehensive Habitat Restoration Plan since species known to exist within the County would be expected to move into the region once the habitat is re-established.

3.4 THREATENED AND ENDANGERED SPECIES

The following data gaps have been identified, which may limit the assessment of threatened and endangered species for habitat restoration:

- Letters have been sent to the US Fish & Wildlife Service and the NYSDEC Natural Heritage Program, in order to obtain up-to-date information regarding the presence or absence of threatened and endangered species or rare plant communities at Onondaga Lake or along the stream corridors of Nine Mile Creek, Tributary 5A, the East Flume, Harbor Brook, Onondaga Creek, Ley Creek, Bloody Brook, and Sawmill Creek. This information is expected to be received shortly; and, thus is not expected to inhibit the development of a Comprehensive Habitat Restoration Plan.

SECTION 4

SUMMARY

4.1 SUMMARY

Existing literature was reviewed to develop an understanding of the inherent capability of Onondaga Lake, its tributaries, and surrounding lands to support aquatic species and wildlife. The ability of a watershed to support wildlife is dependent upon the presence of functional wetlands and well-vegetated terrestrial buffers surrounding the watershed's streams and lakes. Watersheds often lack adequate vegetated buffers due to urban development, residential development, infrastructure improvements, and agricultural practices.

The Onondaga watershed has been impaired by human development, industrial pollution, domestic pollution, urban and rural non-point pollution, and natural disturbances (i.e., mudboils). These processes have fragmented and degraded habitat resources within the watershed, thus compromising Onondaga Lake watershed's ability to support wildlife. However, improvements have been made within the past 25 years and can continue with a comprehensive plan to prioritize areas for restoration. Restoring aquatic habitats, vegetated buffers, and wetlands can improve in-stream fish habitat, provide corridors for the movement and dispersal of wildlife throughout a watershed, and enhance and protect water quality in the watershed.

Watershed habitat restoration can be accomplished by starting at the headwaters and progressing toward the primary basin. For some of the tributaries, the watershed headwaters are relatively unimpaired. However, several projects within the urban corridor of Onondaga Creek have been implemented and efforts upstream will be designed to incorporate these projects. Current and future projects will be considered and incorporated during development of the plan. A system will be developed to rank stream and lakeshore segments to identify the most impacted area, moderately impacted area, and low impact areas. Potential locations for habitat restoration and in-stream improvements along and within the tributaries can initially be identified using existing land use and topographic maps. These selected locations can then be further evaluated, prioritized, and specific plans developed at these general locations.